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The first stage of this research project consisted of (1) an in-plant study of electro-mechanical technician operations to determine what skills and knowledge combinations are required, (2) in-depth interviews with administrative and supervisory personnel in 26 selected industrial organizations geographically distributed from New England to California, and (3) a measure of the quantitative need for technicians with electro-mechanical training through a survey of 93 organizations employing technicians who work with both electrical and mechanical devices and systems. The second stage of the project incorporated known principles of technical curriculum design with the findings of the field study to develop a proposed curriculum providing the unique requirements for the electro-mechanical technician. The curriculum plan differs significantly from any known technical education program and incorporates a number of ideas which resulted directly from the suggestions made by employers. It calls for new combinations of course work, facilities, and instructional procedures that differ in many respects from those in single technology instruction programs. The curriculum is presented as a 2-year program including courses in the areas of electro-mechanics, physics, electricity-electronics, mechanics, math and general education. (HC)

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EDUCATIONAL PLANNING FOR AN EMERGING OCCUPATION,

A Summary Report of a Research Project in Electromechanical Technology.

Educational planning for emerging occupational fields can be especially effective when the findings of well-planned research studies are used to modify, extend, or reorient existing educational services. Research in occupational education should uncover new and more effective techniques of occupational analysis and translate the findings of this analysis into new educational programs. This is a four-step process: (1) occupational analysis; (2) program planning; (3) program development and testing; and (4) documentation and dissemination of the results.

A research project recently completed by the Oklahoma State University (Contract No. OE-6-85-057) covered phase one and two of this process. The occupational field under study was the emerging field of electromechanical technology. Phase one of the project was a field study of the electro-mechanical technician occupation with a concentration on the unique educational requirements of the occupations. Phase two was the design of an educational program to provide these unique requirements.

The field study of occupational needs was conducted in two parts. The first part consisted of an in-plant study of the electro-mechanical technician occupations to determine what skills and knowledge combinations are required and whether or not existing educational services are providing these requirements. Depth interviews were held with administrative and supervisory personnel in 26 selected industrial organizations. These organizations ranged in size from 50 employees to more than 35,000 and were geographically distributed from

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New England to California. The field interviews identified an immediate and urgent need for individuals with a background of education and training significantly different from that obtained in existing technical education programs. Details of this need and the specific occupational requirements may be found in Part One of the project report.

The second part of the field study obtained a measure of the quantitative need for technicians with electromechanical training. A mailed survey was used to obtain information from 93 organizations employing technicians who work with both electrical and mechanical devices and systems. These 93 organizations expect to employ 20,329 additional electro-mechanical technicians by 1970 - a total 25% greater than their combined need for electronic technicians and mechanical technicians. A summary of the returns from this survey as shown in Table I.

A Panel of Consultants with national representation provided advisory services and assisted in planning and conducting the field study. These consultants were selected to represent several kinds of industrial activities such as manufacturing, research, distribution, and service. The organizations selected included: the computer industry, electronics companies, government agencies, instrument makers, technical schools, and technical publishers. The panel played a vital role in the development and conduct of the study. In fact, the success of the study, as measured by the consistency and validity of the findings, was due primarily to the leadership and specific contributions of the Panel members.

During the course of the field interviews the research consultant probed for information and attitudes regarding the skill and knowledge required in industrial occupations of the type under consideration. An interview schedule was used but no attempt was made to obtain a set of

TABLE I

EMPLOYMENT AND PROJECTED NEEDS FOR
TECHNICIANS IN 93 INDUSTRIAL ORGANIZATIONS

Organizations by Principal Product or Activity	Number of Responses	No. of Technicians* with Specialized Training				Projected Needs for Technicians (New Hires) Electronics		Mechanical		Electro-mech.	
		Total	Electrial	Mechanical	Other	1967	1970	1967	1970	1967	1970
Manufacturing	60	34,303	30,351	2,552	1,400	2,944	10,301	840	2,530	4,666	18,478
Research & Devel	14	973	405	280	288	87	131	64	113	77	177
Design	3	111	76	33	2	4	4	5	5	13	19
Calibration & Test	12	1,501	1,176	214	111	62	102	26	56	1,060	1,652
Other	4	81	15	41	25	1	3	7	15	4	3
Total	93	36,969	32,023	3,120	1,826	3,098	10,541	942	2,719	5,820	20,329

*Includes only those who work with both Electrical (Electronic) and Mechanical Devices and/or Systems

answers to a rigidly structured information form. Rather it was thought more important, at this stage, to rely on the researcher's background experience in curriculum planning and technical teaching to interpret and record responses as objectively as possible. The principal advantage of this procedure appeared to be in establishing rapport with the industrial representatives involved. Also it conserved valuable time, an important consideration when busy administrative personnel were contributing to the study.

The second stage of the research project (program planning) incorporated the findings of the field study in a proposed curriculum plan. An outline of the curriculum is shown in Table II. Details of the program, including suggestions for staff and facilities, are included in Part Two of the project report. This curriculum plan differs significantly from any known technical education program and incorporates a number of ideas which resulted directly from the suggestions made by employers during the interview phase of the field study.

The need for equal attention to mechanical and electrical principles throughout the training program was underscored by employers. The systems and devices with which these technicians work are often extremely complex electrical-electronic-mechanical combinations. Employers emphasized the need for technicians with sufficient knowledge of electrical and mechanical principles to make judgments where both are involved. It was pointed out that individuals trained as specialists in either of these two fields tend to avoid decision-making responsibilities where the two elements are interdependent. In extreme cases, electronics specialists literally refuse to become involved in decision-making where mechanical problems appear. Mechanical

Table II

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ELECTRO-MECHANICAL TECHNOLOGY CURRICULUM

	ELECTRO-MECHANICAL COURSES*	PHYSICS COURSES	ELECTRICAL-ELECTRONIC COURSES	MECHANICAL COURSES	MATH & GENERAL EDUCATION COURSES	
	CLASS 1 LAB 3 CR. 2	CLASS 3 LAB 2 CR. 4	CLASS 3 LAB 4 CR. 4	CLASS 1 LAB 3 CR. 2	CLASS 5 CR. 5	CLASS 1 CR. 1
1st TERM	MECHANICAL COMPONENTS AND INTRODUCTION TO ELECTRO-MECHANICAL SYSTEMS	TIME AND SPACE UNITS BASIC ENERGY SYSTEMS MECHANICS (STATICS, DYNAMICS) MECHANICAL MEASUREMENTS — TEMPERATURE, PRESSURE	ATOMIC AND MOLECULAR STRUCTURE (CONDUCTORS, SEMI-CONDUCTORS) BASIC ELECTRICAL UNITS D.C. CIRCUITS A.C. CIRCUITS	USE OF HAND TOOLS FITS AND FINISHES THREADS AND FASTENERS MACHINES AND MACHINE PROCESSES	REVIEW OF INTER-MEDIATE ALGEBRA TRIGONOMETRY ADVANCED ALGEBRA	TECHNICAL REPORT WRITING
	CLASS 1 LAB 2 CR. 2	CLASS 3 LAB 2 CR. 4	CLASS 3 LAB 4 CR. 4	CLASS 3 LAB 2 CR. 4	CLASS 3 LAB 0 CR. 3	
2nd TERM	HIGH ENERGY LIGHT SYSTEMS HYDRAULIC AND PNEUMATIC DEVICES HIGH VACUUM EQUIPMENT	SOLID STATE PHYSICS PRINCIPLES OF HEAT AND HEAT TRANSFER LIGHT AND OPTICS FLUID MECHANICS	A.C. CIRCUITS (CONTINUED) VACUUM TUBES SEMI-CONDUCTORS AND CIRCUITS POWER SUPPLIES AMPLIFIERS	MATERIALS TESTING ENGINEERING MATERIALS - METALS, TIMBER, PLASTICS SIMPLE STRUCTURES HEAT TREATMENT COMPOSITE MATERIALS	APPLICATIONS OF ANALYTIC GEOMETRY AND CALCULUS	
SUM					OPTIONAL SUBJECTS - ASSOCIATE DEGREE REQUIREMENTS, CHEMISTRY, ETC.	
	CLASS 3 LAB 2 CR. 4	CLASS 3 LAB 2 CR. 4	CLASS 3 LAB 4 CR. 4	CLASS 2 LAB 6 CR. 4	CLASS 2 LAB 0 CR. 2	
3rd TERM	SYNCHROS, RESOLVERS SERVO-MOTORS AND GENERATORS CHOPPERS, TACHOMETERS SERVO AMPLIFIERS HYDRAULIC SERVOS DIGITAL-ANALOG CONVERTORS TELEMETERING DEVICES RECORDERS, PLOTTERS	ELECTRICAL MOTORS AND GENERATORS SPEED CONTROL TRANSMISSIONS CLUTCHES SERVO MECHANISMS INTRODUCTION TO CLOSED LOOP SYSTEMS	LOGIC CIRCUITS LOGIC SYSTEMS SYSTEMS ANALYSIS TIMING AND WAVE SHAPING CIRCUITS MEASURING INSTRUMENTS ELECTRICAL TRANSDUCERS	GEARS AND GEAR TRAINS PLANE MOTION DIFFERENTIAL MOTION MECHANICAL INTEGRATION TORQUE AMPLIFICATION AND FORCE AMPLIFIERS CLUTCHES AND COUPLINGS BEARINGS LUBRICATION	NUMBER SYSTEMS LOGIC SYSTEMS BOOLEAN ALGEBRA	
	CLASS 3 LAB 3 CR. 4	CLASS 3 LAB 3 CR. 4	CLASS 1 LAB 6 CR. 3		CLASS 3 CR. 3	CLASS 3 CR. 3
4th TERM	ELECTRO-MECHANICAL SYSTEMS DESIGN PRINTERS DIGITAL READOUT MISSILE CONTROL ELEVATOR CONTROL TAPE TRANSPORTS TELETYPEWRITERS DATA STORAGE & RETRIEVAL	ELECTRICAL, MECHANICAL, HYDRAULIC PROCESS CONTROLLER VARIABLE POWER DEVICES COMPUTERS CLOSED LOOP SYSTEMS	DESIGN PROBLEM PROBLEM ANALYSIS DATA COLLECTION TECHNIQUES DATA EVALUATION TECHNIQUES PROBLEM DEFINITION PROBLEM SOLUTION(S) SOLUTION EVALUATION SOLUTION IMPLEMENTATION VERIFICATION		ECONOMICS	COMMUNICATIONS

* THE DEVICES AND SYSTEMS TO BE USED WILL BE SELECTED INDUSTRIAL APPLICATIONS. THE ITEMS SHOWN ARE TYPICAL.

ADMISSION REQUIREMENTS:
HIGH SCHOOL ALGEBRA, TRIGONOMETRY, AND MECHANICAL DRAWING.

A PRE-TECHNOLOGY TERM WILL BE NECESSARY FOR STUDENTS NOT MEETING THESE REQUIREMENTS.

specialists are similarly reluctant to work with systems and devices that include electronic elements. Throughout the field study employers emphasized the critical need for persons who feel equally at home in each of these elements.

Equal, if not more, importance was attached to the electromechanical technician's responsibility for the communication of facts and ideas. It was apparent from the discussions with employers that the dual-technology functions of a technician working this capacity include a significant responsibility for interpreting technical information - as input for his own needs and as output for others. Here again, the unique nature of the communication skills needed in this occupation must be given consideration in the design of the curriculum. The need appears to be not so much for grammatical expertise as for technical accuracy. Obviously one without the other would be insufficient; both are required and both must be provided in the educational program.

The procedure followed in developing the electromechanical technology curriculum plan was to apply known principles of technical curriculum design to the findings of an occupational study. The study revealed a need for technical personnel with new combinations of skills and knowledge. The resulting curriculum plan consists of new combinations of course work and calls for facilities and instructional procedures that differ in many respects from those in single-technology instruction programs. The plan will, of necessity, require further development, modification, and evaluation in an actual teaching-learning situation.

An important part of the curriculum development process was the correlation of occupational analysis with instructional program planning throughout the project. This correlation was incorporated at several

points in the project. The first point at which this occurred was a briefing session for the Panel of Consultants on the general form of technology curriculums. This step is extremely important. Industrial personnel are generally unfamiliar with the procedures and processes of specialized occupational education programs. There are many kinds and levels of occupational education. Unless advisory groups of this nature understand the limitations of two-year programs they may not be realistic in making an identification of the occupations to be studied. Before any attempt is made to study occupational needs, it is the responsibility of the technical education specialist to delimit the proposed educational program. Failure to do this may result in much time being wasted by studying occupations for which the two-year technical program is not required. It is well to remember, also, that industrial job classifications and educational terminology are not yet sufficiently precise to provide the degree of reliability needed in educational planning.

Much additional developmental work will be required to make the proposed program a reality. In its present form it represents the best judgment of experienced technical education curriculum specialists as to the content, organization, and level of instruction required to prepare individuals for the electro-mechanical technician occupations. Much of the proposed program is new. Existing courses in electrical, electronic, and mechanical disciplines cannot be used without reorganization and a general reorientation to the program objectives. The third and fourth steps of the research process - development and testing, and documentation and dissemination of the results, remain to be accomplished.